

Yale Univ

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## Final Technical Report

This grant was made for the analysis of ROSAT/HRI data from two nearby globular clusters, M4 and M22. Due to an unfortunate series of spacecraft failures, data from M4, originally scheduled for Cycle 2, have yet to be obtained. Currently, this observation is scheduled for September 1994. The preparatory work already accomplished (see below) will allow us to complete the scientific analysis of these data with no additional funding. In the case of M22, the ROSAT data have been obtained and analyzed (see below) and a paper is in preparation. The completion of this work awaits the release of already obtained HST images, which we wish to compare to the X-ray image.

*preparatory work*

In advance of receiving the ROSAT data, we have performed a variety of preparatory tasks. Since this project is the first soft X-ray observation analyzed at Yale, we have had to prepare a software environment appropriate for such an analysis. In particular, we have imported the PROS package, and implemented it on the department's Sun workstation cluster. We have also obtained and used the Einstein data base in its CD format to study previous observations of M22.

Since identification of optical counterparts of potential sources will be crucial to the science, we have obtained and analyzed ground based optical images of both clusters in UBVRI and narrow band H $\alpha$ . These data have proved useful in other contexts — the M4 data have been used in an upcoming paper identifying the optical counterpart of the radio pulsar PSR1620-26. We have also analyzed archival HST data of M4 — a report of this work has been published (Bailyn & Mader, 1993).

*analysis of X-ray data*

As noted above, the observations of M4 have not yet been carried out. The M22 data, however, have been obtained and analyzed. A number of sources have been identified, as listed in the accompanying table. In particular, we confirm the existence of the central cluster source, and the diffuse source previously identified by Hartwick et al. (1982 ApJ 254, L11). The extended source appears to be significantly smaller than in the Einstein data — we are currently re-analyzing both data sets to determine whether this difference could be due to the difference in spectral sensitivity of the two instruments, or whether it requires an intrinsic change in the source. As yet, we have not been able to identify any of the sources in our optical data — this is perhaps not surprising, given the crowding in the field. Fortunately, however, HST images of the center of this cluster will become available this summer, so we will delay submission of our paper in preparation (Bailyn et al. 1994) until we can examine these images.

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### Bibliography

Bailyn, C. D. & Mader, V. 1993, "HST Observations of Blue Stragglers in M4", in *Blue Stragglers*, A. S. P. Conference Series #53, ed. R. A. Saffer, p. 177.

Bailyn, C. D. et al. 1994, "X-ray and Optical Observations of the Core of M22", in preparation.

### Sources Detected in M22

source #	$\alpha$ (J2000)	$\delta$ (J2000)	luminosity <sup>a</sup>	comments
1	18 36 24.8	-23 54 36	$3.8 \pm 0.8$	central source
2	18 35 50.6	-23 46 50	$37.7 \pm 5.2$	extended source
3	18 36 49.0	-23 48 11	$6.4 \pm 2.8$	
4	18 35 59.0	-23 54 58	$6.5 \pm 2.0$	

<sup>a</sup> Luminosity in units of  $10^{31}$  ergs/s, assuming a thermal brehmsstrahlung spectrum with  $T = 5$  keV.